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Patent Claims

1. A measurement element (1, 2, 3) for determination of a flow rate of a fluid which is flowing around the measurement element (1, 2, 3), by means of a optical waveguide (4) for carrying an electromagnetic wave along its longitudinal extent and at least one electrical heating element (5, 6), which is arranged adjacent to the optical waveguide (4) and by means of which heat can be applied to the optical waveguide (4), characterized in that the optical waveguide (4) has at least two fiber Bragg grating sensors, and an electromagnetic wave which can be injected into the optical waveguide (4) can be influenced as a function of the temperature of the optical waveguide (4) at the location of the fiber Bragg grating sensors, which is dependent on the flow rate of the fluid.

2. The measurement element as claimed in claim 1, characterized in that the measurement element (1, 2, 3) is in the form of a rod.

3. The measurement element as claimed in claim 1 or 2, characterized in that the measurement element (1, 2, 3) is elastic.

4. The measurement element as claimed in one of claims 1 to 3, characterized in that the heating element (5, 6) is formed from metal.

5. The measurement element as claimed in one of claims 1 to 4, characterized in that the heating element (5, 6) is formed by an electrically conductive coating on the optical waveguide.

6. The measurement element as claimed in one of claims 1 to 5, characterized in that the heating element (5,

6) has a constant electrical resistance per unit length.

7. The measurement element as claimed in claim 6, characterized in that the resistance per unit length is largely independent of the temperature in the operating temperature range.

8. The measurement element as claimed in one of claims 4 to 7, characterized in that the heating element is formed by a heating conductor in the form of a heating loop.

9. The measurement element as claimed in one of claims 1 to 5, characterized by a sheath (8).

10. The measurement element as claimed in claim 9, characterized in that the sheath (8) is composed of a ceramic material.

11. The measurement element as claimed in claim 9, characterized in that the sheath (8) is composed of metal.

12. The measurement element as claimed in claim 11, characterized in that the sheath (6) at the same time forms the heating element.

13. A method for determination of a flow rate of a fluid by means of a measurement element (1, 2, 3) around which the fluid flows, as claimed in one of the preceding claims, with an electromagnetic wave being injected into an optical waveguide (4), which carries the wave, of the measurement element (1, 2, 3), with the electromagnetic wave being influenced by the optical waveguide (4), which comprises at least two fiber Bragg gratings, as a function of its local temperature at the location of the fiber Bragg grating sensors, which corresponds to the flow rate of the fluid, with the influence of the electromagnetic wave

being determined, and with the flow rate of the fluid along the longitudinal extent of the measurement element (1, 2, 3) being determined from this.

14. The method as claimed in claim 13, characterized in that the electromagnetic wave is formed by an electromagnetic pulse.

15. The method as claimed in claim 13 or 14, characterized in that the measurement element (1, 2, 3) is heated in its longitudinal extent by a heating element (5, 6) during the measurement.

16. The method as claimed in one of claims 13 to 15, characterized in that a constant electric current is applied to the heating element (5, 6).

17. The method as claimed in one of claims 13 to 16, characterized in that two or more measurements are carried out with a different amount of heat applied.

18. The method as claimed in claim 17, characterized in that the flow rate of the fluid along the longitudinal extent of the measurement element (1, 2, 3) is determined from the difference between at least two measurements with a different amount of heat applied.

19. The method as claimed in one of claims 13 to 18, characterized in that a gas flow of a gas turbine (9) is used as the fluid.

20. A continuous flow machine (9) having rotor blades (11) which are arranged on a rotor shaft (10) which is mounted in a housing such that it can rotate, and having stator blades (12) which are arranged such that they are rotationally fixed, characterized by a measurement element (1, 2, 3) which is arranged in a flow channel (13) in the continuous flow machine (9), as claimed in one of claims 1 to 12, for measurement of a fluid flow rate.

21. The continuous flow machine as claimed in claim 20, characterized in that the measurement element (1, 2, 3) is arranged radially with respect to an axis (14) of the rotor shaft (10) in the flow channel (13).

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22. The continuous flow machine as claimed in claim 20 or 21, characterized in that the measurement element (1, 2, 3) is arranged coaxially with respect to the axis (14) of the rotor shaft (10) along a circular line in the flow channel (13).

23. The continuous flow machine as claimed in one of claims 20 to 22, characterized in that two or more measurement elements (1, 2, 3) are arranged axially spaced apart in the flow channel (13).

24. The continuous flow machine as claimed in one of claims 20 to 23, characterized in that the flow rate of the fluid can be determined using a method as claimed in one of claims 13 to 19.

Patent Claims

1. A measurement element (1, 2, 3) for determination of a flow rate of a fluid which is flowing around the measurement element (1, 2, 3), by means of a conductor (4) for carrying an electromagnetic wave along its longitudinal extent and at least one electrical heating element (5, 6), which is arranged adjacent to the conductor (4) and by means of which heat can be applied to the conductor (4), characterized in that an electromagnetic wave which can be injected into the conductor can be influenced as a function of the temperature of the conductor (4), which is dependent on the flow rate of the fluid.

2. The measurement element as claimed in claim 1, characterized in that the measurement element (1, 2, 3) is in the form of a rod.

3. The measurement element as claimed in claim 1 or 2, characterized in that the measurement element (1, 2, 3) is elastic.

4. The measurement element as claimed in one of claims 1 to 3, characterized in that the conductor (4) is an optical waveguide.

5. The measurement element as claimed in one of claims 1 to 4, characterized in that the heating element (5, 6) is formed from metal.

6. The measurement element as claimed in one of claims 1 to 5, characterized in that the heating element (5, 6) is formed by an electrically conductive coating on the conductor.

7. The measurement element as claimed in one of claims 1 to 6, characterized in that the heating element

(5, 6) has a constant electrical resistance per unit length.

8. The measurement element as claimed in claim 7, characterized in that the resistance per unit length is largely independent of the temperature in the operating temperature range.

9. The measurement element as claimed in one of claims 5 to 8, characterized in that the heating element is formed by a heating conductor in the form of a heating loop.

10. The measurement element as claimed in one of claims 1 to 6, characterized by a sheath (8).

11. The measurement element as claimed in claim 10, characterized in that the sheath (8) is composed of a ceramic material.

12. The measurement element as claimed in claim 10, characterized in that the sheath (8) is composed of metal.

13. The measurement element as claimed in claim 12, characterized in that the sheath (6) at the same time forms the heating element.

14. A method for determination of a flow rate of a fluid by means of a measurement element (1, 2, 3) around which the fluid flows, as claimed in one of the preceding claims, with an electromagnetic wave being injected into a conductor (4), which carries the wave, of the measurement element (1, 2, 3), with the electromagnetic wave being influenced by the measurement element (1, 2, 3) as a function of its local temperature, which corresponds to the flow rate of the fluid, with the influence of the electromagnetic wave being determined, and with the flow rate of the fluid along the longitudinal extent of the measurement element (1, 2, 3) being determined from this.

15. The method as claimed in claim 14, characterized in that the electromagnetic wave is formed by an electromagnetic pulse.

16. The method as claimed in claim 14 or 15, characterized in that the measurement element (1, 2, 3) is heated in its longitudinal extent by a heating element (5, 6) during the measurement.

17. The method as claimed in one of claims 14 to 16, characterized in that a constant electric current is applied to the heating element (5, 6).

18. The method as claimed in one of claims 14 to 17, characterized in that two or more measurements are carried out with a different amount of heat applied.

19. The method as claimed in claim 18, characterized in that the flow rate of the fluid along the longitudinal extent of the measurement element (1, 2, 3) is determined from the difference between at least two measurements with a different amount of heat applied.

20. The method as claimed in one of claims 14 to 19, characterized in that a gas flow of a gas turbine (9) is used as the fluid.

21. A continuous flow machine (9) having rotor blades (11) which are arranged on a rotor shaft (10) which is mounted in a housing such that it can rotate, and having stator blades (12) which are arranged such that they are rotationally fixed, characterized by a measurement element (1, 2, 3) which is arranged in a flow channel (13) in the continuous flow machine (9), as claimed in one of claims 1 to 13, for measurement of a fluid flow rate.

22. The continuous flow machine as claimed in claim 21, characterized in that the measurement element (1, 2, 3) is arranged radially with respect to an axis (14) of the rotor shaft (10) in the flow channel (13).

23. The continuous flow machine as claimed in claim 21 or 22, characterized in that the measurement element (1, 2, 3) is arranged coaxially with respect to the axis (14) of the rotor shaft (10) along a circular line in the flow channel (13).

24. The continuous flow machine as claimed in one of claims 21 to 23, characterized in that two or more measurement elements (1, 2, 3) are arranged axially spaced apart in the flow channel (13).

25. The continuous flow machine as claimed in one of claims 21 to 24, characterized in that the flow rate of the fluid can be determined using a method as claimed in one of claims 14 to 20.